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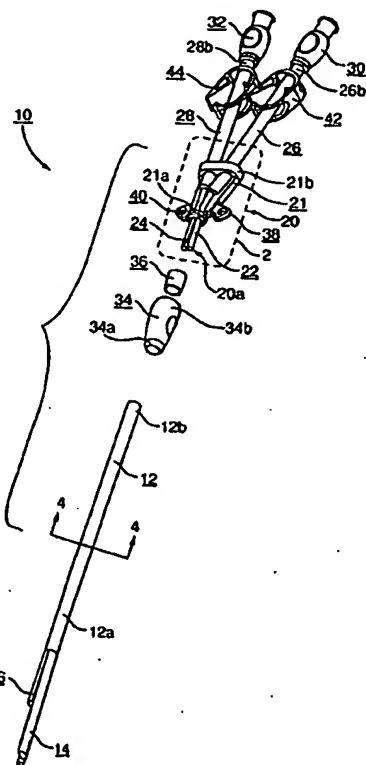
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## MULTI-LUMEN CATHETER WITH ATTACHABLE HUB

### FIELD OF THE INVENTION

The present invention relates generally to medical instrumentation and more specifically to a multi-lumen catheter with a selectively attachable hub assembly that allows the catheter tip 5 to be positioned accurately prior to subcutaneous tunneling.

### BACKGROUND OF THE INVENTION

Catheters, generally, are hollow, flexible tubes for insertion into a body cavity, duct, or vessel to allow the passage of fluids or distend a passageway. Catheters are often used for temporary or long-term dialysis treatment. Dialysis treatment provides for blood to be 10 withdrawn from the patient, purified, and then returned to the patient. Thus, in dialysis treatment, catheters are used to allow passage of a patient's blood into and out of the patient's body. For optimal performance during dialysis treatment, the catheter tips, both in-flow and out-flow, should be placed in close proximity to the heart. Typically, medical personnel use either a double lumen catheter or two single lumen catheters. Both types, however, present certain 15 deficiencies.

While double lumen catheters (e.g., U.S. Pat. No. 4,895,561) allow for a single venous insertion of the catheter into the desired vein, double lumen catheters typically do not provide for accuracy of catheter tip placement. Due to differences among patients, optimal tip position varies from patient to patient. Non-optimal tip position may significantly lower flow values, 20 resulting in less effective dialysis treatment. For current double lumen catheters, a physician must make an estimate regarding the appropriate catheter tube length prior to beginning the procedure of catheterization. Then, a subcutaneous tunnel is made from the preferred end

position of the hub assembly, namely, away from the neck of the patient in order to allow for more convenient access to the dialysis treatment equipment. The double lumen catheter tube is then tunneled forwardly into the patient's vein. The initial estimate and subsequent forward tunneling may result in less than optimal tip placement.

- 5        With the use of two independent catheters (e.g., U.S. Pat. Nos. 5,776,111 and 5,624,413) the problem of tip placement is addressed. The hub assembly of each catheter is removable from the tube and tip portion of the catheter, thereby allowing the catheter tip to be placed directly into the vein and advanced into the desired position. Then, the proximal end of the catheter can be reversed tunneled and trimmed to a desired length. Thereafter, the hub assembly is attached.
- 10      Deficiencies, however, exist in this method of catheterization as well. One problem associated with this method is that this method requires two separate venous insertions, namely, two tunnels and two of each accessory instrument used for the procedure. Therefore, there is increased surgical time required to place two catheters, there are two wound entry sites which doubles the risk of post-surgical infection, and the two catheters together are significantly larger in diameter
- 15      than one double lumen catheter.

#### SUMMARY OF THE INVENTION

- The present invention is a double lumen catheter with a selectively detachable hub assembly that allows the catheter tip to be positioned accurately within a patient's vein prior to subcutaneous tunneling. The distal end of the catheter tube is not permanently attached to the
- 20      hub assembly. Therefore, the catheter may be reverse tunneled after the tips have been positioned.

The hub assembly includes at least two cannulae that coordinate and correspond to at least two lumen at the distal end of the catheter tube. Once the hub assembly is connected to the

catheter tube so as to provide fluid communication therebetween, preferably, a connection cover and a malleable compression sleeve are secured into place. Preferably, the connection cover is threaded to mate with a threaded connection on the hub assembly. The connection cover and the compression sleeve together create force to prevent inadvertent separation of the catheter tube from the hub assembly.

These and other aspects of the present invention as disclosed herein will become apparent to those skilled in the art after a reading of the following description of the preferred embodiments and drawings. The description and drawings are for the purpose of describing a preferred embodiment of the invention and are not intended to limit the present invention.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded, perspective view of a multi-lumen catheter assembly of the present invention.

Figure 2 is an enlarged, exploded, perspective view of a hub assembly of the multi-lumen catheter assembly of the present invention, including a first cross-sectional view of the hub body.

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Figure 3 is an enlarged, exploded, perspective view of the hub assembly and distal portion of a catheter tube of the present invention, including the first cross-sectional view of the hub body.

Figure 4 is a first cross-sectional view of the catheter tube of the multi-lumen catheter of the present invention.

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Figure 5 is an enlarged perspective view of the catheter tube of the present invention.

Figure 6 is a perspective view of an assembled multi-lumen catheter assembly of the present invention.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

As shown in the Figures, the present invention is a multi-lumen catheter assembly 10 having a selectively attachable hub assembly 20. As shown in Figure 1, a multi-lumen catheter tube 12 is formed with a proximal portion 12a and a distal portion 12b. The distal portion 12b of 5 the catheter tube 12 is selectively attachable to the proximal portion 20a of the hub assembly 20. In this manner, the hub assembly 20 may be attached to the catheter tube 12 after insertion of the proximal portion 12a of the catheter tube, including tips 14 and 16, into a patient.

As illustrated in Figure 2, preferably, the hub assembly 20 has a first cannula 22 and a second cannula 24. Each of the cannulae has a proximal portion 22a and 24a, respectively, and a 10 distal portion 22b and 24b, respectively. Further, each cannulae 22 and 24 has an associated extension tube, 26 and 28 respectively. Each of the extension tubes 26 and 28 has a proximal portion 26a and 28a, respectively, and a distal portion 26b and 28b, respectively. Each of the extension tubes 26 and 28 are in fluid communication with the first cannula 22 and second 15 cannula 24, respectively, through appropriate connection of respective proximal and distal portions, namely connection of the cannulae distal portions 22b and 24b with extension tube proximal portions 26a and 28a, respectively. While the drawings depict the hub assembly with two cannulae, any appropriate configuration and number of cannulae should be considered within the scope of the present invention.

As shown in Figure 2, preferably, the hub body 21 is formed to maintain the angle A 20 between the first extension tube 26 and the second extension tube 28 at about 15 degrees. This angle is preferred based upon the necessity for connecting the catheter assembly 10 to the fluid conveying device, e.g., dialysis equipment.

Returning to Figure 1, the hub assembly 20 further includes a first connector 30 and a

second connector 32. The connectors 30, 32 may be luer fittings, as are known in the art. The first connector 30 is securely attached to the distal portion of the first extension tube 26b and the second connector 32 is securely attached to the distal portion of the second extension tube 28b. Each of the connectors 30, 32 preferably is attachable to a fluid conveying device (not shown), such as dialysis equipment, as is known in the art. Thus, the respective cannulae 22 and 24 are in fluid communication with extension tubes 26 and 28, respectively. Therefore, the cannulae 22, 24 provide for respective in-flow and out-flow operation of the fluid conveying device.

Each extension tube 26 and 28 has a clamp, 42 and 44, respectively, for clamping the extension tubes 26 and 28 when the catheter assembly 10 is not connected to a fluid conveying device.

The hub body 21 has two suture wings 38 and 40, which can be used to suture the catheter assembly 10 to the patient to maintain the position of the catheter assembly 10 after insertion into the patient.

As shown in Figure 3, the hub assembly 20 preferably is formed such that each proximal end of the cannulae 22a and 24a has a generally D-shaped cross-section. Preferably, the distal portion of each of the cannulae 22b and 24b has a generally O-shaped cross-section. As such, preferably, the proximal portions 26a and 28a of each of the extension tubes 26 and 28a have a generally O-shaped cross-section and are configured to receive the distal portions 22b and 24b of the respective first and second cannulae 22 and 24. The shape and cross-section configuration of the cannulae 22, 24 the extension tubes 26, 28 and the lumens 13, 17 of the catheter tube 12, may be varied, and, thus, the scope of the present invention should not be limited to the above-described preferred configuration.

Preferably, a hub body 21 is formed around the proximal portions of each of the

extension tubes and the distal portions of each of the cannulae. As illustrated in Figure 2, the hub body 21 provides for protection against disconnection of the several connections between cannulae 22, 24 and extension tubes 26, 28. Further, the hub body 21 provides a structure for connection with the catheter tube 12. More specifically, hub body 21 has a proximal portion 21a and a distal portion 21b. As previously mentioned, the hub body 21 is selectively attachable to the distal portion 12b of the catheter tube 12 so as to provide fluid communication between the respective cannulae 22 and 24 (via proximal portions of the cannula 22a and 24a) with the lumens 13 and 17, respectively, of the catheter tube 12, which is discussed in more detail below.

- As shown in Figure 5, the catheter tube 12 has a first lumen 13 and second lumen 17.
- 10 Each of the first and second lumen 13, 17 has a generally D-shaped cross-section. A longitudinally extending septum 15 defines each lumen 13, 17 up through the distal portion of the catheter tube 12b, as shown in Figure 4. Therefore, each lumen 13, 17 connects to a respective cannula 22, 24 for fluid communication therewith.

Preferably, each lumen 13, 17 of the distal portion 12b of the catheter tube 12, and the 15 proximal ends 22a and 24a of the cannulae 22 and 24 are correspondingly marked by an indicator, such as a color, to ensure proper matched correspondence upon connection. To further ensure matched correspondence, preferably tips 14, 16, extension tubes 26, 28 and connectors 30, 32 follow the same marking pattern. Thus, for example, tip 14, the lumen 13, cannula 22, extension tube 26, and connector 30 are marked with a first indicator (e.g., the color blue), while 20 tip 16, lumen 17, cannula 24, extension tube 28, and connector 32 are marked with a second indicator (e.g., the color red). Thus, the first indicator is associated with one of the lumens and a second indicator is associated with the other lumen, such that the first indicator and the second indicator define a correspondence between that lumen and an associated cannula, extension tube,

and connector. While the indicator may be a visual indicator such as color, a selectively attachable multi-lumen catheter with any indicator, visual, tactile, or otherwise, should be considered within the scope of the invention.

As described above, the invention is described with a preferred embodiment containing

5 two cannulae and a dual-lumen catheter. The present invention should not be limited, however, to this preferred embodiment and other appropriate configurations should be considered within the scope of the present invention. For example, the catheter tube and corresponding cannulae may be a series of concentric tubes of varying diameter. Alternatively, the assembly 10 may provide a similar configuration to that described hereinabove with three (or more) cannulae and a

10 10 triple (or more) lumen catheter tube. The preferred embodiment, however, includes two cannulae with a dual-lumen catheter tube.

Preferably, as shown in Figure 3, the connection between the proximal portions 22a, 24a of the cannulae 22, 24 and the lumens 13 and 17 at the distal portion 12b of the catheter tube 12 is an overlapping fitted connection. However, any other appropriate fastening means, such as

15 detents may be used.

Returning to Figure 1, an example of a preferred connection between hub body 21 and catheter tube 12 is shown, which includes a connection cover 34 having a proximal portion 34a and a distal portion 34b. Connection cover 34 should fit axially about the distal portion 12b of the catheter tube 12. The distal end 34b of the connection cover 34 is appropriately threaded

20 such that the connection cover 34 is selectively attachable to the threaded portion 21a of the hub body 21 such that the catheter tube 12 is securely attached to the hub assembly 20. For example, as illustrated in Figure 1, the connection cover 34 may include female threads to selectively receive the male threads 21a formed on hub body 21.

Preferably, the present invention also includes a compression sleeve 36 that fits axially about the distal portion 12b of the catheter tube 12 as well as fitting axially about the combined proximal portions 22a and 24a of the first and second cannulae 22 and 24. Compression sleeve 36 preferably is formed of malleable material so as to provide further compression about the 5 connection between the cannulae 22 and 24 with the multi-lumen catheter tube 12. The connection cover 34 and the compression sleeve 36 together create force to prevent inadvertent separation of the catheter tube 12 from the hub body 21 after insertion of the catheter tube 12 into a patient.

Figure 6 shows the catheter assembly 10 of the present invention with the hub assembly 10 20 attached to the catheter tube 12.

A preferred method for inserting into a patient the catheter assembly 10 of the present invention requires the following: a multi-lumen catheter tube 12 with, preferably, tapered silicone tips 14, 16, and, as are known in the art, an introducer needle, multiple tear away sheath dilator introducers, J-flex guidewires, trocars, lock right adapters with clamps, injection caps, a 15 scalpel, sutures, and adhesive wound dressing. Additionally, the physician should have access to scissors, forceps, needles dish, syringes and gauzes.

A preferred method for insertion of the catheter of the present invention into a patient's jugular vein begins with placing the patient in a position with the patient's head turned to the opposite side of where the jugular vein is to be cannulated. The anatomical landmark for proper 20 insertion is defined by the triangle formed by the lateral edge of the sternal head, the medial edge of the clavicular head of the sternocleidomastoid muscle, and the upper edge of the clavicle.

The patient's neck and a portion of the patient's thorax beneath the clavicle, preferably at least about 20 centimeters (cm), should be appropriately prepared for incision. Thereafter, the

patient should be draped and local anesthetic should be administered.

Preferably, a skin wheal should be created, taking care to infiltrate the subcutaneous tissue for about 2 to 3 cm. Next, preferably with an 18-gauge needle attached to a syringe, the physician should identify the internal jugular vein by aspiration and then proceed at an angle 5 while continuing to aspirate with the syringe. Once the internal jugular vein has been located, the preferred method includes detaching the syringe while leaving the needle in place. The needle opening should then be occluded and thereafter the J-flex guidewire should be introduced through the needle and into the internal jugular vein. The guidewire should pass without resistance into the exact position. The needle should be removed, thus leaving the guidewire in 10 place. The guidewire should rest at the junction of the superior vena cava and the right atrium. Appropriate guidewire placement can be confirmed with fluoroscopy.

Next, with a scalpel, the physician should make an incision in the skin that is wide enough for the catheter tube 12 to pass. A tearaway sheath dilator may be introduced over the guidewire and into the vein far enough to dilate the vessel. After expanding the vein wall, the 15 guidewire may be removed while occluding the dilator opening. A trocar should be screwed onto the catheter tube 12 by turning the trocar clockwise, but not the catheter tube 12. Turning the catheter tube 12 may cause it to kink. The dilator may be removed, leaving the tearaway sheath in place to introduce the catheter tube 12, again being careful to occlude the sheath opening. As the catheter tube 12 is fed into the sheath the tearaway sheath may be torn away. 20 Care should be taken that the catheter tube 12 does not back out of the vessel.

Air embolus is avoided by the patient's positioning described above, and also by asking the patient to inhale deeply and then hold their breath. At this point, fluoroscopy should be performed to confirm catheter tube 12 placement. The tip 14 of the venus catheter should reach

the opening of the right atrium and the tip 16 of the arterial catheter should be approximately 4 cm higher. As described above, proper positioning is important. Positioning, as described, is believed to prevent blood recirculation during hemodialysis.

Next, a tunnel, of about 8 to 10 cm, should be created in a caudal and internal direction  
5 by means of the tunneler, which may be shaped to physician preference. The catheter tube 12 should be gently pulled through the tunnel until the loop at the original puncture site is gone. When correctly inserted, the catheter tube 12 should rest over the clavicle. Care should be taken to avoid excessive force, as this may cause the catheter tube 12 to separate from the tunnel.  
Preferably, the method includes surveying this area to ensure there are no kinks in the catheter  
10 tube 12 and there is a smooth turn.

Next, while pinching the distal portion 12b of the catheter tube 12, the hub assembly 20 is attached to the catheter tube 12. The connector 34 is backfit over the catheter tube 12. Next, the compression sleeve 36 is backfit over the catheter tube 12. The proximal portions 22a, 24a of cannulae 22, 24 are inserted into lumens 13 and 17, respectively, creating a friction fit.  
15 Preferably, the cannulae 22, 24, or the corresponding extension tubes 26, 28 or the corresponding connectors 30, 32 are marked so that the cannulae 22, 24 are inserted into the correct lumens 13, 17.

After backfitting the connector cover 34 and the compression sleeve 36 over the catheter tube 12, the compression sleeve 36 is slid into a position that is approximately adjacent to the  
20 threaded portion 21a of the hub body 21. Finally, the connector cover 34 is attached to the hub body 21 by turning the connector cover 34 so that the female threaded portion of the connector cover 34 receives the male threaded portion 21a of the hub body 21 thereby creating a secure attachment of the hub assembly 20 to the catheter tube 12. Clamps 42, 44 may be used with

extension tubes 26, 28.

The extension tubes 26, 28 should be filled with 3 to 4cc of heperinized saline, clamped, and attached with the injection cap. X-rays should again be performed to reconfirm placement. The small incision is closed with sutures. The patient is now ready for 5 dialysis.

Preferably, the catheter tube 12 is formed with radioopaque silicone, to facilitate visualization under fluoroscopy.

Although specific embodiments of the present invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. The 10 above detailed description of the embodiment is provided for example only and should not be construed as constituting any limitation of the invention. Modifications will be obvious to those skilled in the art, and all modifications that do not depart from the spirit of the invention are intended to be included within the scope of the appended claims.

What is claimed is:

1. A multi-lumen catheter assembly having an selectively attachable hub, comprising:
  - a multi-lumen catheter tube having a proximal portion and a distal portion; and
  - a hub assembly having a proximal portion and a distal portion,

5 wherein the distal portion of the catheter tube is selectively attachable to the proximal portion of the hub assembly after subcutaneous insertion of the proximal portion of the catheter tube into a patient.
2. The multi-lumen catheter assembly of claim 1, wherein the catheter tube has a first lumen  
10 and a second lumen, and wherein the hub assembly is further comprised of:
  - a first cannula and a second cannula, wherein each of the cannulae has a proximal portion and a distal portion, the proximal portion of the first cannula being connectable with the first lumen of the catheter tube, and the proximal portion of the second cannula being connectable with the second lumen of the catheter tube, to provide for fluid communication therebetween;
- 15 a first extension tube and a second extension tube, wherein each of the extension tubes has a proximal portion and a distal portion, and wherein the proximal portion of the first extension tube is connectable with the distal portion of the first cannula, and the proximal portion of the second extension tube is connectable with the distal portion of the second cannula, to provide fluid communication therebetween; and
- 20 a first connector and a second connector, the first connector being securely attached to the distal portion of the first extension tube and the second connector being securely attached to the distal portion of the second extension tube,  
wherein each of the connectors are attachable to a fluid conveying device to provide fluid

flow between the hub assembly and the catheter tube.

3. The multi-lumen catheter assembly of claim 2, wherein the proximal portion of each of the first and second cannulae have a generally D-shaped cross-section and the distal portion of each of the first and second cannulae have a generally O-shaped cross-section.
4. The multi-lumen catheter assembly of claim 3, wherein the proximal portions of each of the extension tubes have a generally O-shaped cross-section and are configured to receive the distal portion of a respective cannulae.
5. The hub assembly of claim 2 further comprising:  
a hub body formed about the connection between the proximal portion of each extension tube with the distal portion of each cannula.
- 15 6. The multi-lumen catheter assembly of claim 5, further comprising:  
a connection cover having a proximal portion and a distal portion, wherein the cover fits axially about the distal portion of the catheter tube; and  
a compression sleeve, the compression sleeve fitting axially about the distal portion of the catheter tube and the proximal portion of the first and second cannulae;  
20 wherein the distal end of the cover is selectively connectable to the hub assembly.
7. The multi-lumen catheter assembly of claim 6, wherein the hub body has a proximal portion and a distal portion, the proximal portion of the hub body being selectively attachable to

the distal portion of the connection cover, such that the catheter tube is securely attached to the hub assembly.

8. The multi-lumen catheter of claim 2, wherein the angle between the first cannula and the 5 second cannula is about 15 degrees.

9. The multi-lumen catheter of claim 1, wherein the proximal portion of the catheter tube further comprises

a first and second lumen, each of the first and second lumens having a generally D-  
10 shaped cross-section, wherein each of the first and second lumens transition toward the distal portion of the catheter tube into a single lumen having a longitudinally extending septum.

10. The multi-lumen catheter of claim 2, wherein  
a first indicator is associated with a first lumen, the first cannula, and the first connector;  
15 and

a second indicator is associated with a second lumen, the second cannula, and the second connector;

such that the first indicator and the second indicator define a matching correspondence  
between the lumens, the cannulae, and the connectors.

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11. A multi-lumen catheter assembly having a selectively attachable hub, comprising:  
a) a multi-lumen catheter tube having a proximal portion and a distal portion and a  
first lumen and a second lumen; and

- b) a hub assembly, the hub assembly further comprising:
- i) a first cannula and a second cannula, wherein each of the cannulae has a proximal portion of D-shaped cross-section and a distal portion of O-shaped cross-section, the proximal portion of the first cannula being connectable with the first lumen of the catheter tube, and the proximal portion of the second cannula being connectable with the second lumen of the catheter tube, to provide for fluid communication therebetween;
  - ii) a first extension tube and a second extension tube, wherein each of the extension tubes has a proximal portion and a distal portion, and wherein the proximal portion of the first extension tube has an O-shaped cross-section and is connectable with the distal portion of the first cannula, and the proximal portion of the second extension tube has an O-shaped cross-section and is connectable with the distal portion of the second cannula, to provide fluid communication therebetween;
  - iii) a first connector and a second connector, the first connector being securely attached to the distal portion of the first extension tube and the second connector being securely attached to the distal portion of the second extension tube; and
  - iv) a hub body having a proximal portion and a distal portion, the hub body being formed about the connection between the proximal portions of each of the first and second extension tubes with the distal portions of each of the first and second cannulae, respectively;
  - v) a first indicator is associated with a first lumen, the first cannula, and the

first connector; and a second indicator is associated with a second lumen, the second cannula, and the second connector, such that the first indicator and the second indicator define a matching correspondence between the lumens, the cannulae, and the connectors;

- 5        c)     a connection cover having a proximal portion and a distal portion, wherein the cover fits axially about the distal portion of the catheter tube; and
- d)     a compression sleeve, the compression sleeve fitting axially about the distal portion of the catheter tube and the proximal portion of the first and second cannulae; wherein the proximal portion of the hub body being selectively attachable to the distal
- 10      portion of the connection cover, such that the catheter tube is selectively attachable to the hub assembly after insertion of the proximal portion of the catheter tube into a patient.

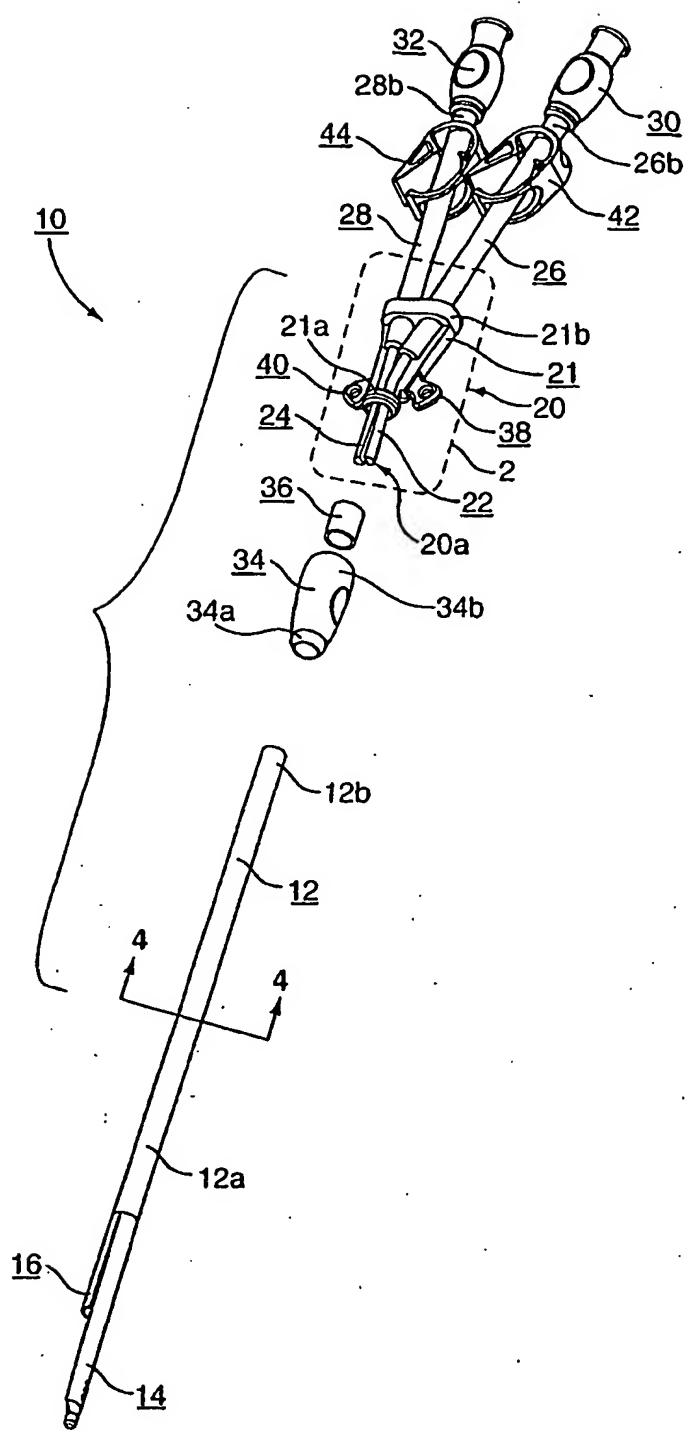
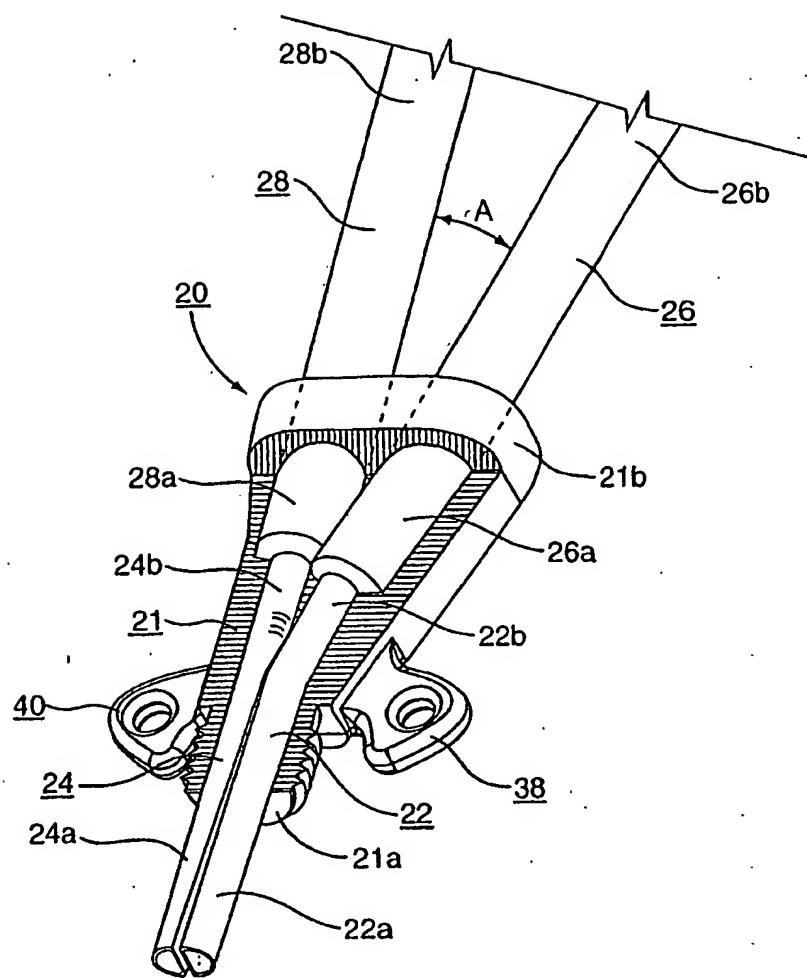


FIG. 1



**FIG. 2**

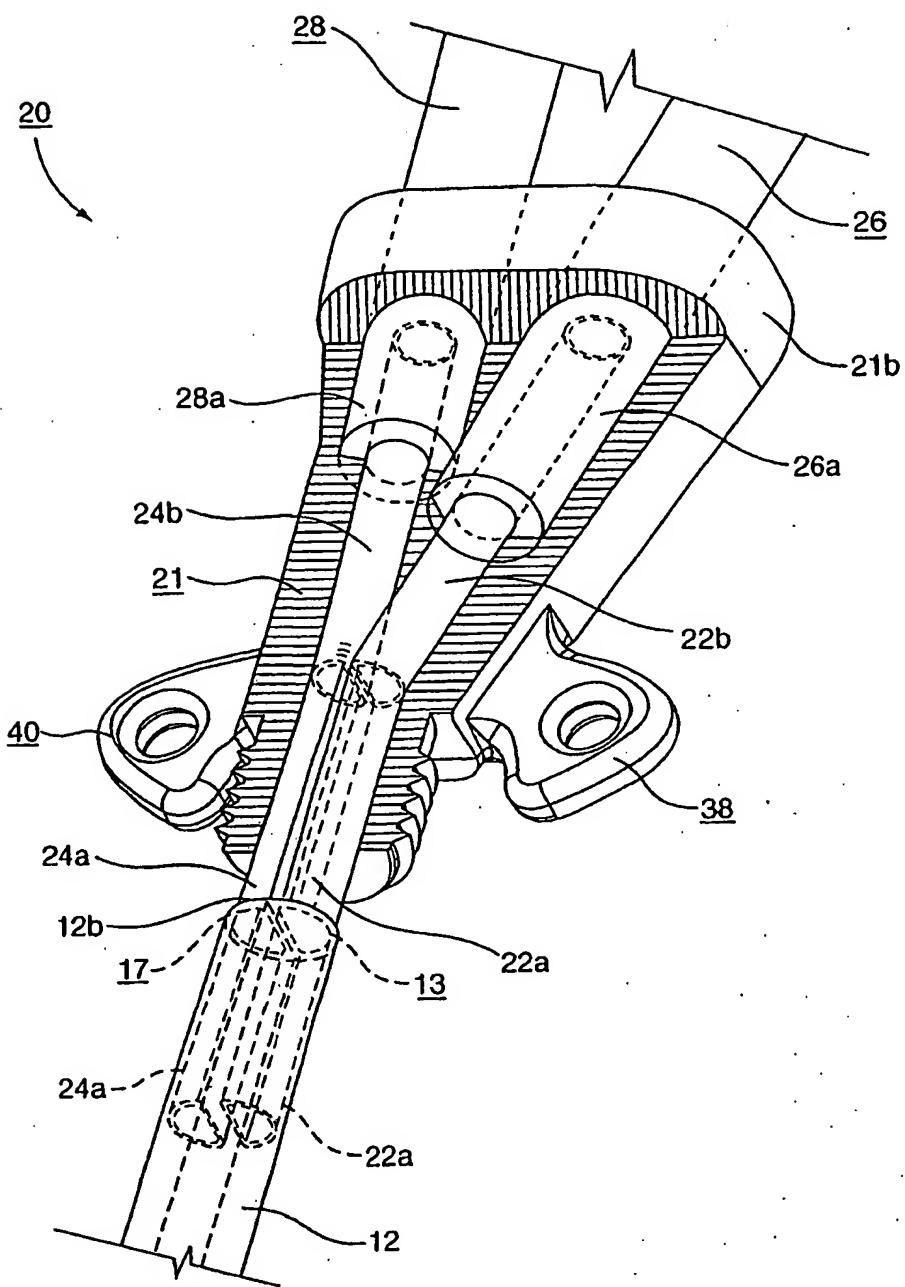
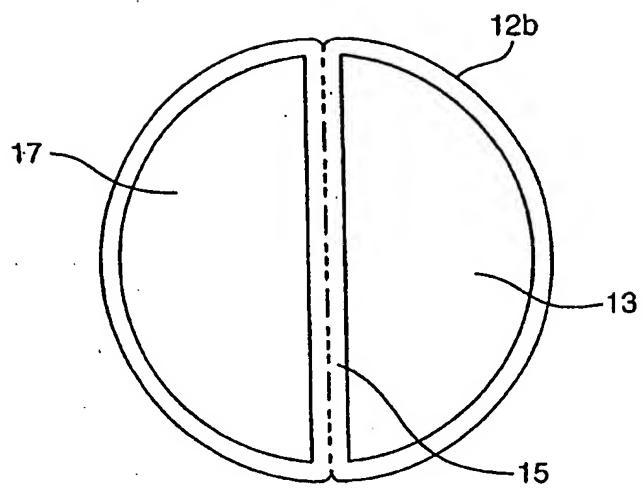
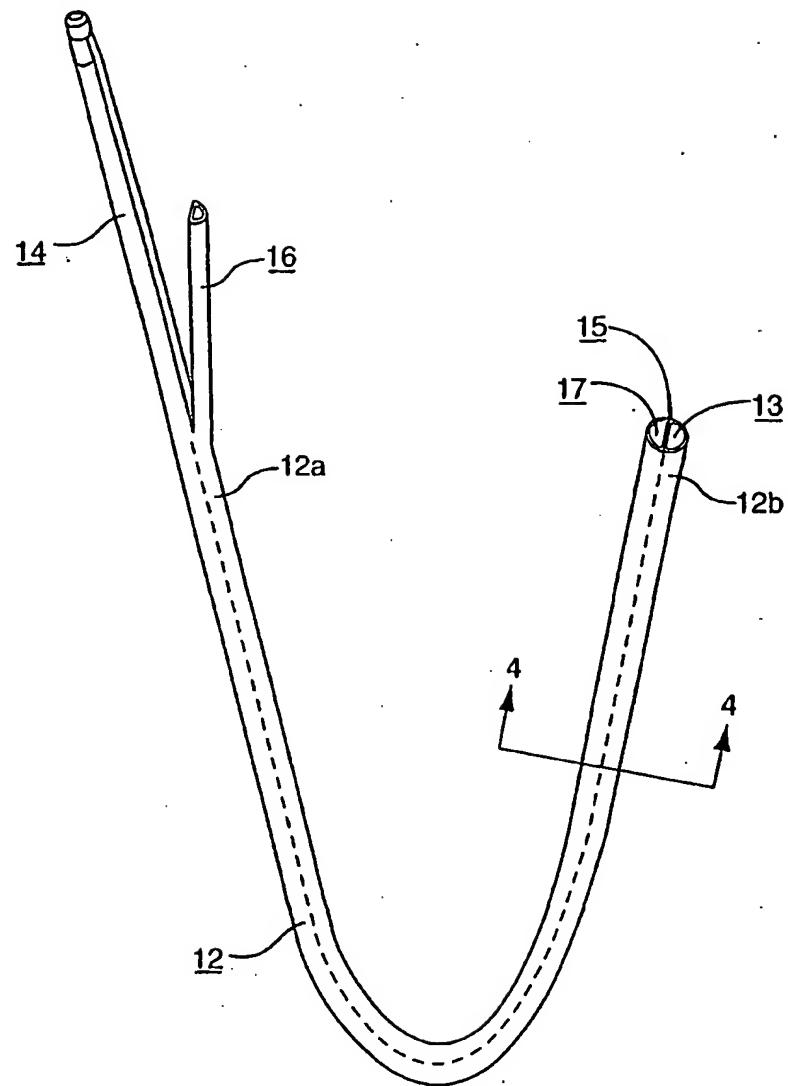


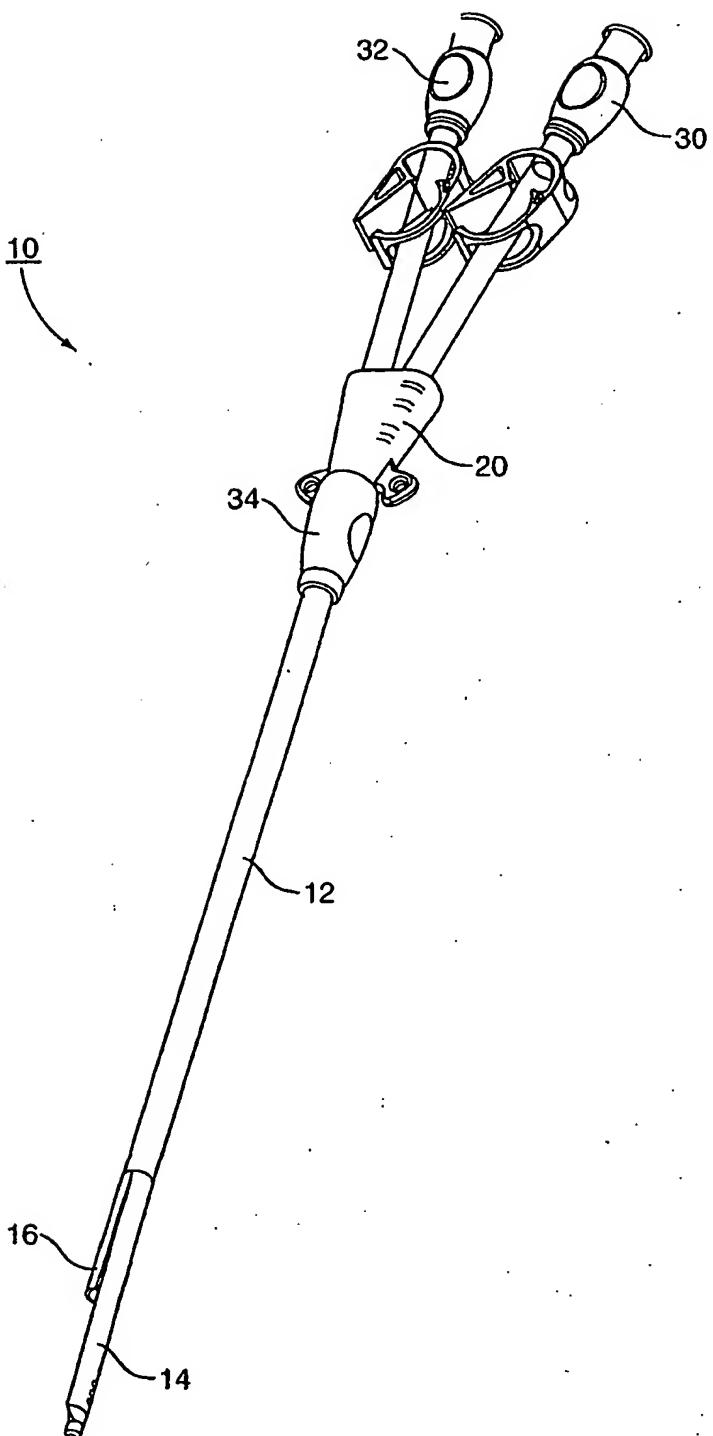
FIG. 3



**FIG. 4**



**FIG. 5**



**FIG. 6**